

Remarks:

Claims 1 and 26 have been amended. Claims 4 and 13-22 were previously cancelled. Accordingly, claims 1-3, 5-12 and 23-26 are currently pending for consideration.

I. Amendments:

Claims 1 and 26 have been amended to recite that formation of chlorate continues in the chlorate reactor. Support for these amendments can be found in the specification at page 7, lines 30-32. No new matter has been added.

II. The Invention:

The presently claimed invention is directed to a process for producing alkali metal chlorate in an electrolytic cell that is divided by a cation selective separator into an anode compartment in which an anode is arranged and a cathode compartment in which a gas diffusion electrode is arranged. The process comprises introducing an electrolyte solution containing alkali metal chloride into the anode compartment and an oxygen-containing gas into the cathode compartment.

The present invention provides a process for producing alkali metal chlorate which avoids the problems of using alkali metal chromates associated with previously known processes that employ gas diffusion electrodes and avoids the costs and handling problems associated with using considerable amounts of hydrochloric acid and alkali metal hydroxide that are employed in other known processes, while at the same time provides an energy-efficient electrolytic process for the production of alkali metal chlorate and makes a large portion of externally added pH-adjusting chemicals superfluous.

III. Rejections:

Claims 1-3, 5, 6, 9-11, 23, 24 and 26 stand rejected under 35 U.S.C. § 103(a), as being unpatentable over Millet (US 5,104,499), in view of Oda et al. (US 4,299,682). The Applicants respectfully traverse.

Millet is directed to an improved process (col.2, l.22-27) which does not need the presence of deleterious hexavalent chromium values. Also, Millet teaches that there is no necessity of separating chloride prior to the desired chlorate, nor does any coupling of chlorate production with any other production occur.

The chlorate is produced in a single stage by electrolysis whereby the chlorate produced is directly separated by crystallization (col.2, l.37-45).

Millet discloses that the electrolyzed solution is separated directly in a crystallization step without a prior stage in a separate reactor. However, the Office Action contends that the crystallizer is a reactor as defined by the claims.

Amended claim 1, however, now clarifies that formation of chlorate occurs in the reactor thereby increasing the concentration of chlorate. The crystallizer of Millet, on the contrary, solely concentrates chlorate. Accordingly, it is respectfully submitted that amended claim 1 is clearly distinguished from the teachings of Millet.

Furthermore, the catholyte of Millet is agitated due to the release of hydrogen. This mechanism does not occur in a gas diffusion cathode since no hydrogen is evolved (col.3, l.31-35, 38-42).

Oda teaches a gas diffusion electrode which imparts low over voltage, excellent reproducibility, excellent durability, and non-deteriorated catalytic activity (col.1, l.59-62). The electrode is suitable for electrolysis of alkali metal chloride or as an electrode in an oxidizer side of a fuel cell.

With respect to the conclusion drawn by the Office Action, i.e., that it would be obvious to replace the hydrogen-evolving electrode of Millet with the gas diffusion electrode of Oda, it is respectfully submitted that Millet discourages replacement of the electrode by teaching that there is no requirement for a special electrode (see Millet at col.2, l.22-27). Furthermore, Millet requires agitation and uniformity by the release of the hydrogen. Should the hydrogen not be evolved, it is submitted that these conditions would not be fulfilled. Accordingly, it is respectfully submitted that Millet discourages

replacement of the hydrogen-evolving electrode. The Office Action acknowledges Millet's teaching that "of importance is that the reaction at the cathode of Millet produces hydrogen gas...". Applicants submit that this statement clearly teaches away from replacing the present electrode of Millet with a non-hydrogen evolving cathode with an oxygen-reducing cathode.

Applicants further take issue with the Office Action's contention that the "cathode reaction provided by the process cell of Oda et al is identical to the cathode reaction provided by the process of Millet." Although NaOH is formed in both reactions, Applicants submit that the cathodic reactions are based on totally different mechanisms, which are as follows:

$\text{H}_2\text{O} + 0.5 \text{O}_2 + 2\text{e}^- \rightarrow 2\text{OH}$ (Oda) including **reduction** of oxygen introduced in the cathode compartment at the gas diffusion electrode (col.2, l.32), i.e. another raw material present in the cathode reaction.

$2\text{H}_2\text{O} + 2\text{e}^- \rightarrow 2\text{OH} + \text{H}_2$ is the conventional hydrogen gas evolving reaction (Millet) without presence of introduced oxygen.

Accordingly, it is respectfully submitted that there would be no incentive for a person of ordinary skill in the art to combine Millet with Oda since the mechanisms for hydrogen-evolving and oxygen-reducing electrodes are so different.

Therefore, it is respectfully requested that the rejections of claims 1-3, 5, 6, 9-11, 23, 24 and 26 over Millet, in view of Oda et al, be withdrawn.

Claims 1, 3-6, 9-11 and 24-26 stand rejected under 35 U.S.C. § 103(a), as being unpatentable over Millet, in view of Shimamune et al (US 6,117,286). The Applicants respectfully traverse.

Shimamune et al teach an electrolytic cell employing a gas diffusion electrode which enables smooth gas feeding and energy savings for producing sodium hydroxide or hydrogen peroxide by electrolysis. Applicants respectfully submit, however, that they are unaware of any disclosure by Shimamune et al regarding the production of chlorate, in particular concentrated chlorate electrolyte in quantities as presently claimed.

Further, for the same reasons discussed above with respect to Millet and the fact that Shimamune et al teach, in line with Oda et al, applications for gas diffusion electrodes other than chlorate production, replacement of hydrogen-evolving cathode would imply modifications of design and process conditions contrary to the teachings of Millet (e.g., agitation would no longer be provided by hydrogen evolved).

Therefore, it is respectfully requested that the rejections of claims 1, 3-6, 9-11 and 24-26 over Millet, in view of Shimamune et al, be withdrawn.

Claims 1-3, 5, 7, 9-11 and 23 stand rejected under 35 U.S.C. § 103(a), as being unpatentable over Cook, Jr. (US Pat. No. 3,897,320), in view of Oda et al. The Applicants respectfully traverse.

Cook is directed to the production of chlorate from alkali metal chloride solution in a two compartment cell equipped with an effective cation-active permselective membrane divider with the production of some chlorate in the anolyte and subsequent electrolysis of the anolyte in a chlorate cell (col.1, l.5-13).

Cook states that "an advantage of this invention is that alkali metal chlorate produced by transmission of hydroxide through the membrane into the anolyte is recovered and the anolyte is subsequently utilized as a feed to a chlorate cell (col.1, l.19-23).

It is further set out that "because the cation-active permselective membrane 23 allows some hydroxyl ions to migrate through it from the catholyte to the anolyte these can react to produce chlorate in the anolyte" (col.2, l.10-12). Cook further teaches that the cation-active permselective membrane should permit from 5 to 50 percent of the caustic produced in the catholyte compartment to migrate to the anolyte compartment (col.7. l.10-13).

Claim 1 of the present invention differs from Cook in at least one aspect, as acknowledged by the Office Action, by defining the use of a gas diffusion electrode and

introduction of oxygen-containing gas in the cathode compartment of the electrolytic cell.

Claim 1 is further distinguished from Cook by defining that the electrolyzed solution from the anode compartment is transferred to a chlorate reactor to further produce a concentrated chlorate electrolyte **in which reactor formation of chlorate occurs**.

In contrast hereto, it is respectfully submitted that Cook teaches transferring the electrolyzed solution to a conventional **non-divided chlorate cell** electrolyzer rather than to a reactor. In such an undivided cell, further chlorate is formed in a **common** compartment.

Applicants submit that one of ordinary skill in the art would not have any reason to modify Cook to arrive at the presently claimed invention, since Cook is silent on gas diffusion electrode-equipped cells, as well as transfer of electrolyzed solution to a reactor to form additional chlorate.

Further, it is respectfully submitted that it would not be obvious to replace the existing hydrogen-evolving cathode of Cook with a gas diffusion electrode of Oda since Oda is silent on chlorate production and there is no reason based on Cook for a skilled person to modify or replace the cathodes used in the chlorine and chlorate cells.

Therefore, it is respectfully requested that the rejections of claims 1-3, 5, 7, 9-11 and 23 under 35 U.S.C. § 103(a), as being obvious over Cook, in view of Oda et al, be withdrawn.

Claims 1-6, 8, 10-12, 23 and 26 stand rejected under 35 U.S.C. § 103(a), as being unpatentable over Wångård (US 5,419,818), with evidence from Cook, and in view of Oda et al. The Applicants respectfully traverse.

Wångård teaches "an ion-selective membrane such as a cation selective membrane" (see col.5, lines 4-6) and not a cation-active permselective membrane as

disclosed by Cook. Applicants submit that they are unaware of any teaching or suggestion by Wanngård that hydroxide ions would be able to cross such a membrane to cause formation of chlorate ions in the anolyte compartment.

Wanngård relates to an integrated process involving a **conventional** hydrogen-evolving cathode. Wanngård regards the problem of reducing chemicals added in the conventional processes for acidification and alkalization (col.2, l.50-52). The electrolysis in the cell equipped with a separator yields an anolyte and a catholyte having lower and higher pH respectively than the chlorate electrolyte supplied to the separator-equipped cell (col.2, l.67-col.3, l.2).

Consequently, it is respectfully submitted that a skilled person would have no reason to modify the teaching of Wanngård in such a way that the process of instant claims 1 and 26 is arrived at since Wanngård is not aiming at providing a divided chlorate cell, and particularly not a divided chlorate cell equipped with a gas diffusion electrode.

On the contrary, Wanngård focuses on providing integrated production of acid and alkali metal hydroxide in a conventional undivided cell but by using a portion of the chlorate electrolyte for production of acid anolyte and alkali metal hydroxide in the catholyte of a divided chloralkali cell. Applicants respectfully submit that one of ordinary skill in the art would not foresee that a divided chlorate cell would advantageously contribute to produce integrally acid and alkali metal hydroxide. In that regard, since several parameters differ between divided and undivided chlorate cells including, e.g., mixing conditions of electrolyte, control of pH, need of supplying acid/hydroxide, it is submitted that one of ordinary skill in the art would be dissuaded from looking for the solution in technology describing divided cells, particularly not Oda, which is silent on integrated production of acid and alkali metal hydroxide and production of chlorate, nor Cook which transfers the anolyte to a further electrolyzing cell.

Finally, regarding claim 26, Applicants point out that claim 26 includes the subject matter of claim 24, however, claim 24 was not rejected in view of Wanngård.

Therefore, it is respectfully requested that the rejections of claims 1-6, 8, 10-12, 23 and 26 under 35 U.S.C. § 103(a), as being obvious over Wanngard, as purportedly evidenced by Cook, in view of Oda et al., be withdrawn.

Conclusion:

In light of the foregoing, Applicants respectfully submit that the application as amended is now in proper form for allowance, which action is earnestly solicited. If the Examiner has any questions relating to this Amendment or to this application in general, it is respectfully requested that the Examiner contact Applicants' undersigned attorney at the telephone number provided below.

Respectfully submitted,



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